interior fabrics caused by solar energy.

through the windshield, it is no longer available to be convected or radiated into the vehicle. This is not the case with stan-

comprehensive measurement than TSET (Total Solar Energy Transmitted) because

Vehicle Test Procedures and Equipment

Test vehicles were standard production models, identical in exterior color (white) and interior trim, and manufactured on the same day. The only difference was windshield glazing, which involved three different configurations.

Two separate comparisons were made: the Sungate windshield (with standard green-tinted door glass) versus a standard green-tinted windshield and door glass combination; and the Sungate windshield (with standard green-tinted door glass) versus dark green-tinted windshield and door glass.

Upon arrival at the Arizona test site, each vehicle was equipped with an assortment of instrumentation and portable data acquisition units, providing a total of 64 different channels for the accumulation of relevant data.

Equipment/measurements included:

Sixteen air temperature measurements, with six sensors located at passenger breath level, four just above floor level, and six at seat arm levels. For these and all other air temperature measurements, platinum thin film resistance temperature detectors (RTDs) were used.

Two predicted mean vote comfort measurements using Brüel and Kjaer Thermal Comfort Meter Type 1212, located in the front and rear of the vehicle. Both were positioned to approximate average passenger upper chest level.

Two pressure transducers for monitoring the low and high pressure lines of the air conditioning systems.

Ten material temperatures, including the instrument panels, steering wheel and seats, using platinum thin film resistance temperature detectors (RTDs).

Four globe thermocouples for determining radiant temperatures.

Ten glass temperature measurements, five inside and five outside each vehicle.

Eight solar sensors, three inside each vehicle and five mounted on a rack attached to the roof. These measured solar irradiance available to the roof of the vehicle and to each of the glass surfaces at their installation angle. Those inside the vehicle measured irradiance passing through the glass.

Two air flow transducers, positioned as necessary to provide information on air movement inside the vehicle for boundary conditions in PPG's analytical modeling work.

Two heat flux transducers, also positioned as necessary to provide information for modeling work.

Eight air temperatures, in positions including air conditioner outlets, the return air duct and ambient temperatures under the car and on the roof.

Testing

Baseline evaluations of each vehicle were conducted before and after the test program, and as an additional precaution against possible bias, each vehicle, in turn, was used as the base vehicle in replicate glass tests. In comparing differences attributed to glass performance, only variations greater than those observed in baseline tests or between replicate glass tests were considered significant.

Prior to testing, each vehicle was kept in a covered area, sheltered from direct sunlight, with all doors, including the rear hatch, kept open.

Individual tests consisted of a one-hour period parked in direct sunlight, followed by drives of 15 minutes at 30 mph (48 kph) traveling east, then 15 minutes at 30 mph (48 kph) traveling west, 15 minutes at 50 mph (80 kph) traveling north, and 15 minutes at 50 mph (80 kph) traveling south.

Throughout each driving period, continuous monitoring of compressor inlet and outlet pressures and temperatures provided necessary data for calculating the amount of work required by each air conditioning system.

TSETR includes the re-radiated energy component.

TSETR values for the Sungate windshield, compared with green-tinted and dark green-tinted windshields are shown in the chart below. The values are not intended to be a specification, but rather to illustrate relative performance of a reflective product and an absorbing product.

Test Results

The following charts represent a summary of results obtained through PPG's 1991-92 Arizona Testing Program. All test vehicles were identical except for the glazing, and each was parked in direct sunlight for one hour prior to undergoing a prescribed driving schedule.

Conclusions

Specially designed to combat the sun's radiation, the Sungate automotive windshield from PPG increases passenger comfort by reducing solar heat build-up within the vehicle and by shortening automotive cool-down time.

Test results show that in vehicles equipped with the Sungate windshield, surface temperatures are reduced by as much as 20° F. Consequently, automotive air conditioning loads are significantly reduced, which should have a positive impact on fuel consumption and air conditioner life.

In addition, because of its superior blockage of infrared and ultraviolet rays, the Sungate automotive windshield also protects interior automotive fabrics from deterioration and discoloration caused by solar radiation.

Owner Survey Results

According to a recent survey of Sungate windshield owners, U.S. consumers are well aware of these advantages. More than 93% recognized the relationship between exterior automotive glass and solar heat build-up; more than 60% believed this influence to be extensive; and 90% said they'd want the Sungate automotive windshield in their next vehicle.

For more information on the Sungate automotive windshield, call PPG at (412) 434-3406, or write to:

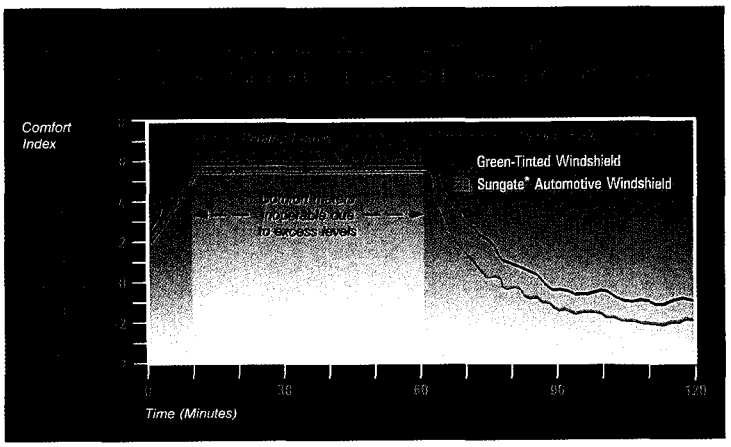
PPG Automotive OEM Products
One PPG Place—32E
Pittsburgh, PA 15272

PPG AUTOMOTIVE PRODUCTS

Total Solar Energy Transmitted and Radiated (TSETR)
Sungate Windshield vs. Standard Green- and Dark Green-Tints
(Total Windshield Thickness = 5.4 mm)

	70% Light Transmittance Requirement (%)	*75% Light Transmittance Requirement (%)*
Standard (Green-Tinted) Windshield	66	66
Dark Green-Tinted Windshield	61	66
Sungate Automotive Windshield	50	52

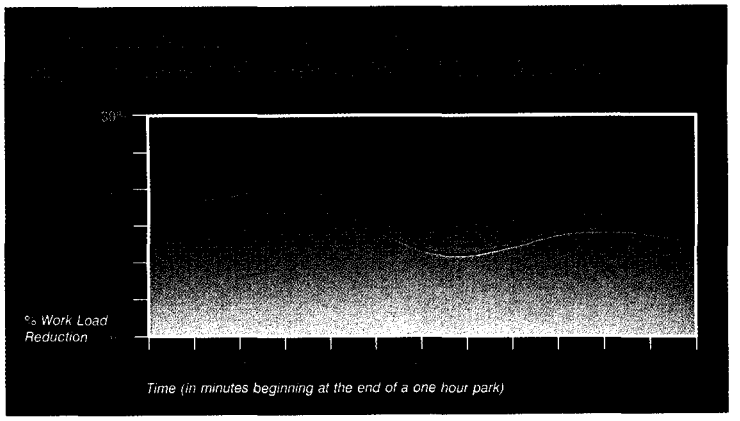
Notes: The above values represent a stationary vehicle.



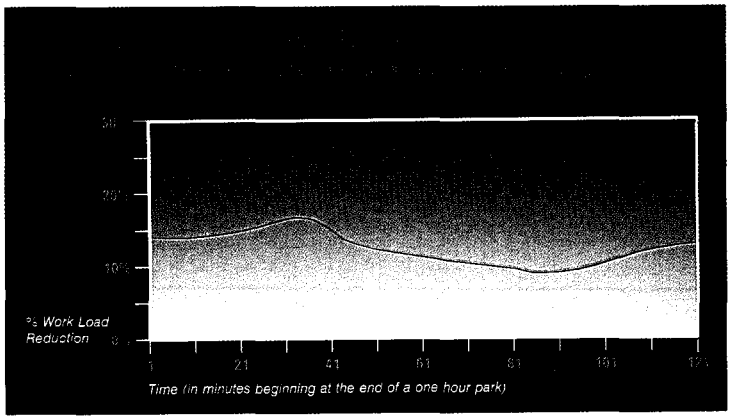
Notes:

- When interior temperatures reached a level of "6" or greater on the Comfort Index, Comfort Meters became inoperable. Operation resumed as temperatures decreased.
- Both vehicles were equipped with standard green-tinted door glass.

On the Comfort Index, shown above, "0" indicates that a vehicle occupant would not have a preference to feel warmer or cooler. Using this as the major reference point, the Comfort Meter Chart compares the front seat comfort levels of two vehicles differentiated only by windshield glazing. It indicates that the vehicle equipped with a Sungate windshield reached comfort in 15 minutes, while the vehicle with a standard green-tinted windshield took 25 minutes to reach the same level. The ambient temperature during this test was 93° F.



Note: Both vehicles equipped with standard green-tinted door glass



Note: "Sungate vehicle" equipped with standard green-tinted door glass; "base vehicle" equipped with dark green-tinted windshield and door glass.

Work Load Reduction Charts show a representative percentage work reduction of the automotive air conditioner in a vehicle equipped with a Sungate automotive windshield as compared to "base" vehicles with standard green-tinted or dark green-tinted windshields and door glass. On average, air conditioners in vehicles with Sungate windshields performed 10% to 20% less work while cooling than did those in vehicles equipped with absorbing glasses.